

Objections

The amendment filed June 5, 2009 was objected to because it allegedly introduces new matter. The Office alleges on page 3, in section 7 of the Office action that the phrase “using only the single captured image” of claim 50 does not have any support in the specification. Applicants respectfully disagree.

Applicants direct the Examiner to the following sections of the application as-filed:

The title of the application is “METHOD AND APPARATUS FOR *SINGLE IMAGE* 3D VISION GUIDED ROBOTICS” (emphasis added).

Page 1, lines 11-13 of the application state, “The invention relates to the field of vision guided robotics, and more particularly to a method and apparatus for *single image* three dimensional vision guided robotics.” (emphasis added).

Page 9, lines 1-2 of the application state, “Selection from the *object’s image* of at least 5 features, and determining the position of the features in *the image*” (emphasis added).

Page 12, line 29 of the application states, “*an* image of the object is captured” (emphasis added).

Page 16, line 16-17 of the application state, “For instance, the formation of a *single image* may be accomplished...” (emphasis added).

Page 16, line 20 of the application state, “A *single image* is then formed...” (emphasis added).

As shown above, the application as-filed repeatedly refers to use of just a single image. Thus, support exists in the application as-filed for “using only the single captured image,” as recited in claim 50.

The abstract was objected to because a web address should allegedly not be in the Abstract. However, Applicants submit a web address does not appear in the Abstract. The web address to which the Examiner is referring appears in the description portion of the specification on page 6, line 11. Applicants are not aware of any particular restrictions on web addresses appearing in the description portion of the specification.

Therefore, Applicants respectfully request the objections be withdrawn.

Rejections Under 35 U.S.C. § 112, First Paragraph

Claim 50 was rejected under 35 U.S.C. § 112, first paragraph, as allegedly failing to comply with the written description requirement. The Examiner alleges that the phrase “using only the single captured image” of claim 50 does not have any support in the specification. As shown above, the application as-filed repeatedly refers to use of just a single image. Thus, support exists in the application as-filed for “using only the single captured image” as recited in claim 50.

Therefore, Applicants respectfully request the rejection be withdrawn.

Rejections Under 35 U.S.C. § 103

Claims 33-35, 38, 41, and 42 were rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent Publication No. 2002/0159628 to Matusik et al. (hereinafter “Matusik”) in view of U.S. Patent No. 4,942,539 issued to McGee et al. (hereinafter “McGee”). Claims 36 and 37 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Matusik in view of McGee and further in view of U.S. Patent No. 5,802,201 issued to Nayar et al. (hereinafter “Nayar”). Claim 39 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Matusik in view of McGee and further in view of U.S. Patent Publication No. 2004/0233461 to Armstrong et al. (hereinafter “Armstrong”) and U.S. Patent Publication No. 2010/0040255 to Rhoads. Claim 40 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Matusik in view of McGee and further in view of Armstrong. Claim 43 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Matusik in view of McGee and further in view of U.S. Patent Publication No. 2001/0034481 to Horn. Claim 44 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Matusik in view of McGee and Horn and further in view of Nayar. Claims 45-47 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Matusik in view of McGee and Horn and further in view of U.S. Patent Publication No. 2010/0231706 to Maguire, Jr. Claim 50 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Matusik in view of Horn and further in view of U.S. Patent No. 6,584,375 to Bancroft et al. (hereinafter “Bancroft”) and U.S. Patent Publication No. 2001/0033685 to Ishiyama. Claims 51 and 52 were rejected under 35 U.S.C. § 103(a) as being unpatentable over

Matusik in view of Horn, Bancroft and Ishiyama and further in view of U.S. Patent Publication No. 2001/0055069 to Hudson.

Applicants respectfully traverse the rejections. Claim 50 is independent so will be discussed before the claims that depend therefrom. Claim 50 recites (emphasis added):

50. A method useful in three-dimensional pose estimation for use with a single camera mounted to a movable portion of a robot, the method comprising:
capturing a two-dimensional image of a volume containing a target object;
locating a number of features in the captured image of the target object; and
determining an object space-to-camera space transformation for the target object based at least in part on a position of at least some of the located features using only the single captured image and an algorithm that employs a known or determinable physical relationship between at least some of the located features.

The Office states that Matusik does not teach certain limitations which are purportedly taught by the secondary reference Horn. Office Action, page 16, third paragraph. In particular, the Office appears to rely on Horn for teaching determining an object space-to-camera space transformation for the target object based at least in part on a position of at least some of the located features using only the single captured image. Office Action, page 16, third paragraph. Applicants respectfully disagree. To the contrary, Horn describes using first and second captured images as opposed to “only the single captured image” as recited in claim 50, and does not mention anything about camera space.

In particular, the Abstract of Horn states (emphasis added):

Methods, systems and computer program products are provided for determining an obscured contact point based on a visible portion of an acoustic sensor of a medical device contacting a patient by *acquiring a first image* containing an upper surface of the acoustic sensor from a first viewpoint *and a second image* containing the upper surface of the acoustic sensor from a second viewpoint different from the first viewpoint.

Relevant portions of the above language also appear in paragraph 9 of Horn:

These and other objects of the present invention are provided by methods, systems and computer program products which determine an obscured contact point based on a visible portion of an acoustic sensor of a medical device contacting a patient by *acquiring a first image* containing an upper surface of the acoustic sensor from a first viewpoint *and a second image* containing the upper

surface of the acoustic sensor from a second viewpoint different from the first viewpoint.

Furthermore, Horn does not mention anything about camera space, let alone “determining an object space-to-camera space transformation,” as recited in claim 50. Horn states in paragraph 9 that “the centroid may be determined in three dimensional space by determining the centroid of the acoustic sensor in each image and then determining the location [of the centroid] in three dimensional space from the locations in the images.” Horn does not differentiate any three dimensional coordinate system belonging to the camera versus a three dimensional coordinate system belonging to the object of Horn (i.e., the acoustic sensor).

Therefore Horn does not teach or suggest “determining an object space-to-camera space transformation for the target object based at least in part on a position of at least some of the located features using only the single captured image,” as recited in claim 50.

Also, there is no teaching, motivation or suggestion to combine the teachings of Matusik and Horn. The Office states that a modification of Matusik to include the alleged teachings of Horn above “would have introduced object space coordinates into Matusik’s et al. teaching, thereby ‘the camera position and field of view are also preferably selected *so that the number of features, m, in each image are the same*, and that the same m objects have been imaged in each image.’ (see Horn’s section [0055])” (emphasis added). Office Action, page 16, last paragraph. However, even if Horn could introduce “object space coordinates” to the system of Matusik that were not already made use of in Matusik, it is unclear why the system of Matusik would benefit by having the number of features be the same in every image. In fact, the system of Matusik works by taking different images of a single object while rotating it on a turntable (see Abstract of Matusik), so the number of features in every image would necessarily not be the same for each and every position of the turntable of Matusik in order to capture the different texture data of the object appearing at various angles completely surrounding the object. In sum, there is no teaching, motivation or suggestion to combine the teachings of Matusik and Horn, nor does the Office offer any sufficient reason. See MPEP 2141¹.

¹ (“The key to supporting any rejection under 35 U.S.C. 103 is the clear articulation of the reason(s) why the claimed invention would have been obvious. The Supreme Court in *KSR* noted that the analysis supporting a rejection under 35 U.S.C. 103 should be made explicit. The Court quoting *In re Kahn*, 441 F.3d 977, 988, 78 USPQ2d 1329, 1336 (Fed. Cir. 2006), stated that “[R]ejections on obviousness cannot be sustained by mere

The other references cited by the Office (Bancroft, McGee, Nayar, Armstrong, Rhoads, Maguire, Jr., Bancroft, Ishiyama, and Hudson) do not cure the deficiencies above of Matusik Horn, and the Office does not allege that these references disclose such elements (i.e., “determining an object space-to-camera space transformation for the target object based at least in part on a position of at least some of the located features using only the single captured image”). Also, the Office provides no teaching, motivation or suggestion to combine the system of Matusik as modified by the teachings of Horn and Bancroft (in support of the rejection of claim 50) with the references McGee, Nayar, Armstrong, Rhoads, Maguire, Jr., Ishiyama, or Hudson.

Therefore, claim 50 is allowable over the references cited by the Office.

Claims 33-47, 51, and 52 depend from claim 50 and are therefore also allowable over the references cited by the Office by virtue of their dependencies for at least the reasons above and also for the additional novel and nonobvious features recited therein.

Claims 53 and 58 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Matusik in view of McGee and Ishiyama. Claim 54 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Matusik, McGee, Ishiyama and Horn. Claims 55 and 59 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Matusik in view of McGee and Ishiyama and further in view of Nayar. Claims 56 and 60 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Matusik in view of McGee and Ishiyama and further in view of Nayar.

Applicants respectfully traverse the rejections. Claim 53 recites (emphasis added):

53. An apparatus useful in robotics, the apparatus comprising:
a single camera operable to capture a number of images of a calibration object;
means for calibrating the camera, by:
determining a set of intrinsic parameters of the camera from at least one of the
number of images of the calibration object captured by the camera; and

conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness.” *KSR*, 550 U.S. at 398, 82 USPQ2d at 1396.”).

determining a set of extrinsic parameters of the camera from at least one of the number of images of the calibration object captured by the camera, the set of extrinsic parameters comprising a camera space-to-training space transformation defining a transformation between a camera space reference frame and a training space reference frame; and

means for estimating a pose of a target object, by:

capturing a two-dimensional image of a volume containing a target object; and

locating at least six features in the captured image of the target object; and

determining an object space-to-camera space transformation based at least in part on a position of at least some of the located features in *solely the captured image* using an algorithm that employs a known or determinable physical relationship between at least some of the located features.

The Office appears to rely on Matusik for teaching determining an object space-to-camera space transformation based at least in part on a position of at least some of the located features *in solely the captured image*. Office Action, page 19, lines 11-13. Applicants respectfully disagree. To the contrary, Matusik describes extracting object shape and texture data from multiple images, i.e., “first and second set of images” (Matusik, Abstract) as opposed to “features *in solely the captured image*” as recited in claim 53.

The other references cited by the Office (McGee, Horn, Bancroft, Nayar, Armstrong, Rhoads, Maguire, Jr., Bancroft, Ishiyama, and Hudson) do not cure the deficiencies above of Matusik. Therefore, claim 53 is allowable over the references cited by the Office.

Claims 54-56 depend from claim 53 and are therefore also allowable over the references cited by the Office by virtue of their dependencies for at least the reasons above and also for the additional novel and nonobvious features recited therein.

Claim 58 recites, *inter alia*, “determining an object space-to-camera space transformation based at least in part on a position of at least some of the located features using the captured *image without any additional captured images*” (emphasis added). This language is similar to the features of claim 53 discussed above regarding “solely the captured image,” and is thus allowable over the references cited by the Office for at least the same reasons above as for claim 53.

Claims 59-60 depend from claim 58 and are therefore also allowable over the references cited by the Office by virtue of their dependencies for at least the reasons above and also for the additional novel and nonobvious features recited therein.

Conclusion

Applicants respectfully submit that the pending claims are in condition for allowance. Any remarks in support of patentability of one claim should not be imputed to any other claim, even if similar terminology is used. Any remarks referring to only a portion of a claim should not be understood to base patentability on that portion; rather, patentability must rest on each claim taken as a whole. Applicants do not acquiesce to each of the Examiner's rejections and to each of the Examiner's assertions regarding what the cited references show or teach, even if not expressly discussed herein.

If the undersigned attorney has overlooked a relevant teaching in any of the references, the Examiner is requested to point out specifically where such teaching may be found. In light of the above remarks, Applicants respectfully submit that all pending claims are allowable. Applicants, therefore, respectfully request that the Examiner reconsider this application and timely allow all pending claims. The Examiner is encouraged to contact the undersigned by telephone to discuss the above and any other distinctions between the claims and the applied references, if desired. If the Examiner notes any informalities in the claims, the Examiner is encouraged to contact the undersigned by telephone to expediently correct such informalities.

Respectfully submitted,
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